

Template for Annual Report (**20 page limit**); report is due on **June 30, 2015**  
In addition to uploading your report to Grants Online, please send a pdf of the report to Amrith Sagar (amrith.sagar@noaa.gov).  
Annual Reports will be posted on the RISA webpage.

1. **Award Title** (must match the name on your award):

California-Nevada Climate Applications Program (CNAP)

2. **Performance Period** (from previous progress report through May 30, 2015):

June 1, 2014 - May 30, 2015

3. Who are your **team members**? Please include graduate students and post-doctoral researchers in this list.

Daniel Cayan, Michael Dettinger, Kelly Redmond, Julie Kalansky, Tim Brown, Alexander Gershunov, Randall Hanson, Sam Iacobellis, Nina Oakley, David Pierce, Mary Tyree, Tamara Wall, LeRoy Westerling.

4. What are your **new areas of focus or partnerships** that have begun this past year? Please provide some context for why you are expanding into this area or partnership.

We have begun focusing on the usability of web-based tools. This includes conducting more research into constructing websites and web based tools that are easy for people to use and interpret. In various meetings, such as the Great Basin Climate Forum, we have presented on web-tools and have asked for feedback on the usability and how to make the tools more user-friendly. This type of evaluation is being built into all web applications we create. As an example the Climate Outcome Likelihood Tool is in the beta version and water managers, the target audience, have been providing feedback on how to make the tool more helpful.

As a result of the mixing height project (see below), which suggests that there may be more days with the necessary conditions allowing for control burns, we have started looking at air quality and public health.

Based on a request by the Tahoe Environmental Research Center and the National Park Service, we are looking at cold-air pooling in the Sierras and around Lake Tahoe. One of the main questions is, do the regions of cold-air pooling buffer the impact of climate change or change with a similar, or greater, trend as surrounding areas? This has implications for land management and ecosystem preservation.

For a new project with the Great Basin LLC and the Institute for Tribal and Environmental Professionals we are developing 3 day workshops for Tribal Environmental Professionals on the impacts of climate change.

Through a SARP sponsored project we have started working closely with the Russian River Watershed (Sonoma and Mendocino Counties, CA) stakeholders to understand the impacts of drought. These results, along with the result of a mega-drought scenario stress test, will be used to develop a drought readiness report which will include suggestions that the cities and counties can undertake to mitigate the impacts of drought.

Dan Cayan, Sam Iacobellis and Mary Tyree are collaborating with Sea Grant, University of California Santa Barbara and other colleagues on a coastal ecosystem vulnerability assessment for the Santa Barbara area. A core element is a set of hourly sea level projections over the 21<sup>st</sup> Century using CMIP5 GCMs derived using a modified statistical model of Cayan et al. 2008.

Dan Cayan, Sam Iacobellis and Mary Tyree are collaborating with colleague P. Bromirski of Scripps Institution of Oceanography (SIO), the California Ocean Science Trust, the California Department of Water Resources (DWR), Ford Engineering and ES Associates to describe possible global climate change effects on coastal flooding. The project is being supported by CNAP for parts of Cayan, Iacobellis and Tyree efforts that are supplementing DWR support and a NOAA SARP grant to carry out this project. Objectives are to provide coastal decision makers a resource for sea-level rise and floodplain management in the context of the National Flood Insurance Program that will allow them to conform to FEMA requirements. The study is being shaped by organized survey and group discussions with a set of coastal managers, scientists and practitioners. Products will include: 1) a supplement to the FEMA “Quick Guide” for community preparation for coastal flooding (which to this point has not considered sea level rise); 2) a technical manual to provide a guide for local communities (planners and technical practitioners) that connects SIO modeling outputs to FEMA hazard mapping guidelines; 3) a complete report that will provide a more comprehensive narrative or summary of the project components and incorporate key information needs identified in the Needs Assessment and Focus Group meetings.

We have begun developing an evaluation “tool-kit” to help both CNAP and the larger RISA community evaluate the effectiveness of their programs. This research began because we saw a clear need to begin 1) more formally assessing the outcomes from a deliberative co-produced approach to climate science research in CNAP and the RISA network at large and 2) the need to develop evaluation metrics that provide salient and credible feedback to the RISA teams, stakeholders, and RISA program managers to identify approaches that are successful as well as understanding failures more clearly.

For questions 5-7, you can combine these questions for each of the main projects you are highlighting, if it makes sense to do so.

5. Please provide a list of up to 5 **research findings** – Please try to include examples that span disciplinary and interdisciplinary work. Examples might be: a) dust-on-snow reduces Colorado River runoff by 5%, or b) analysis revealing the presence or absence of adaptive capacity in legal and policy frameworks for managing resources.

Dan Cayan, Mike Dettinger and Kelly Redmond, as members of the California Department of Water Resources' (DWR) Climate Change Technical Advisory Group (CCTAG) have contributed to a report on the use of climate models and associated technical tools for use in water resource planning. DWR empaneled the CCTAG in February 2012 in order to advise DWR on the scientific aspects of climate change, its impacts on water resources, the use and creation of planning approaches and analytical tools, and the development of adaptation responses. Dan Cayan, Mary Tyree and David Pierce focused on the determination of 10 CMIP5 GCMs that are suitable to use for climate projections for the state as it relates to water supply. The report with this information will be published sometime this summer/fall.

Through working with the US Forest Service on their Southern Sierra Management Plan, LeRoy Westerling showed that fuel management can mitigate the impacts of climate change. Fuel management includes both controlled burns and physical removal of fuel. Model projections predict that under climate change scenarios fuel management can reduce the hectares burned by between 5 and 44% and reduce fire particulates by between 7-47%. The range depends on the type of fuel management regime and the percentage of forest managed. When 100% of the forest undergoes fuel treatment the hectares burn and particulates are close to 1961-1990 conditions. This will be published as part of the US Forest Service Southern Sierra Management Plan.

Using a new novel analysis using satellite derived atmospheric optical depth, Tim Brown and co-authors found that turbulent-kinetic energy calculations perform best in determining the "true" height of the planetary boundary layer (mixing height). The important implication is that heights are often actually higher than what is forecast by current methods, and higher heights allow for more prescribed burning days. Related to the finding above, this would increase the possibility for land managed fuels treatments given that other factors of planned burning are in alignment. This finding has been submitted to Journal of Operational Meteorology.

In collaboration with NIDIS, Anne Steinemann worked with stakeholders to identify their needs for drought indicators. This needs assessment concluded that users water indicators that include percentile thresholds for drought onset and recovery, severity levels, anomalies, and consecutive time periods for triggering. Based on this and using precipitation as an example a percentile based indicator was developed through collaboration between Anne Steinemann, Sam Iacobellis and Dan Cayan. A NIDIS meeting to be held next month will provide feedback from stakeholders on this indicator representation. In addition, work by Shraddhanand Shukla, Anne Stienemann, Dan Cayan and Sam Iacobellis has shown that for California when drought conditions occur in December there is a greater likelihood than any other month that California will have an annual drought. This work has been submitted to the Journal of Applied Meteorology and Climatology.

In continuation of work that Mike Dettinger began last year on the importance of the extreme precipitation events to California's water year, recent findings include: 1) monthly mean precipitation contribution from smaller storms are relatively uniform between December and March, but the increase in largest storms between December and February explains shape of the monthly mean precipitation in California; 2) 80-90% of the variance of California's precipitation is explained by the 5% of wettest days; 3) climate model projections generally predict an increase in the contribution to total precipitation of the 5% of wettest days whereas the remaining days tend to decrease. This work has been submitted to Water Resources

Research.

6. Please provide a list of up to 5 **outreach activities** that you have undertaken in the past year. OPTIONAL: If applicable, please share the outcomes of these activities.

Nina Oakley has lead education outreach to K-12 teachers and students on weather and climate related research. Through these events teachers and students are more aware of how weather and climate are monitored and how scientists infer information about past climates. Students are able to recognize a weather monitoring station and its instruments. In addition students have a better understanding of what causes drought conditions in the Great Basin and the uncertainty scientists have about when a drought will end.

April 8<sup>th</sup> was the Great Basin Climate Forum and it focused on drought. The forum had full attendance and the schedule included talks about energy's role in a sustainable water future, drought monitoring tools in the Great Basin, the effects of drought on forest health and had time set aside for climate resiliency planning.

Tim Brown has lead advance advanced climate and wildland fire training. The 2-week course promotes better decision-making and planning using the National Fire Danger Rating System (NFDRS). The class also encouraged the development and implementation of fire danger operating plans at the local level to be integrated into geographic area and national level decision processes.

David Pierce presented at the Coastal Symposium which brought coastal community leaders and consultant together to help coastal cities and consultants plan for sea level rise and climate change in the face of evolving guidelines, various sea level rise models, and emerging information. David talked specifically about climate change in California covering wildfire, heat waves and water supplies.

Kelly Redmond, Anne Steinemann, Mike Dettinger and Dan Cayan have overviewed the development of the ongoing California/Nevada drought, along with prospects for next year in numerous talks to diverse groups including NIDIS drought meetings, the Nevada Water Resource Annual Conference, attendees of the Great Basin Forum, the California legislature and other State officials, San Diego County water districts, the San Diego County Water Authority, the Chapman Conference on the California drought, and the National Park Service at the Yosemite Forum.

7. Please provide a list of **key publications** from the past year - We are seeking ~ 5 publications, give or take a few, to be highlighted on the CPO webpage. These can be either non-peer reviewed or peer-reviewed. For peer-reviewed publications, please list either **published** or in **press**, but **not** "in review". For non peer-reviewed publications, please provide a hyperlink or webpage wherever possible. (You may include a more comprehensive list of publications as an appendix.) **PLEASE SEE COMPLETE PUBLICATION LIST AT END**

Florsheim, J., and Dettinger, M., 2015: Promoting atmospheric-river and snowmelt fueled biogeomorphic processes by restoring river-floodplain connectivity in California's Central Valley: in Hudson, P., and Middelkoop, H. (eds.), *Geomorphic approaches to integrated floodplain management of lowland fluvial systems in North America and Europe*, Springer, 117-140, DOI 10.1007/978-1-4939-2380-9\_6. **[due out in June 2015]**

Oakley, N. S., and Daudert, B., 2015: Establishing best practices to improve usefulness and usability of web interfaces providing atmospheric data, *Bulletin of the American Meteorological Society*, doi: <http://dx.doi.org/10.1175/BAMS-D-14-00121.1>

Pierce, D.W., Cayan, D.R., and Thrasher, B.L., 2014: Statistical Downscaling Using Localized Constructed Analogs (LOCA). *J. Hydrometeor*, **15**, 2558–2585, doi: <http://dx.doi.org/10.1175/JHM-D-14-0082.1>.

Steinemann, A., Iacobellis, S., and Cayan, D., 2015: Developing and Evaluating Drought Indicators for Decision-Making. *J. Hydrometeor*. doi:10.1175/JHM-D-14-0234.1, in press.

8. Please provide up to 3 narrative **examples** from the past year of plans, policies, strategies, tools, agreements, etc. that were proposed, adopted, and/or implemented as a result of prior RISA work.

The work that David Pierce and Dan Cayan have done on downscaling climate model projections using the localize Constructed Analogue (LOCA) method will be used widely in California's fourth Climate Assessment. This product will also go into CalAdapt (<http://cal-adapt.org/>) making it easily accessible for the general public. It is also a product that will be widely used by the US Army Core of Engineers.

Previous work on heat waves and the impact on human health in California showed that the health impacts in different regions correspond to different temperature thresholds. Further in the North Coast and Central Valley humid heat waves are more likely to have an adverse effect on human health. Based on these finding the NWS is experimenting with issuing heat advisories or warning based on different thresholds for the different regions. All western offices of the NWS will be generating a product to address heat advisory and warning taking into account regional specific impacts of heat. (<http://www.wrh.noaa.gov/sto/heat/?day=3&page=gmap>)

In the past year, the State of Bay-Delta Science Report 2008 has been written in as the only document that is an explicit part of the Delta Stewardship Council's Delta Science Action Agenda. This is the long term roadmap for science in the service of management of the Delta. Currently, Mike Dettinger is part of a team that is revising the State of Bay-Delta Science Report and setting up a structure for a 4-yr return cycle.

ArkStorm has been used in local readiness assessments that yield (by the locals) many recommendations for policy and investment actions to prepare. Specifically, ArkStorm has served as a self-TEST of preparedness by Ventura County, San Diego County, and all

Navy and NASA facilities in California and Nevada

Recommendations from the Fire Danger Pocket Card project from last year are being incorporated into the next generation (2016) of the National Fire Danger Rating System

9. How are you measuring the overall impact of your RISA team on decision-making in your region? For instance, how do you know what your program-level impact is?

We have been measuring the overall impact of CNAP through a variety of avenues. We track feedback and requests for information from stakeholders and decisions makers. This has been particularly true at the Great Basin Climate Forum where the attendees take a survey and let us know how often they use climate data and what type of climate data they do use. Along these lines we also keep track of CNAP website hits. This past year the CNAP website has served over 4 terabytes of information/data to about 365,000 visitors requesting a total of 5.5 million pages. In addition the Great Basin Dashboard had 2866 unique web visits and CalClim had over 14,000 visits this last year. As mentioned previously, we have started considering how user friendly our websites and web-based tools are by receiving feedback from the users. This assumes that a more user friendly tool will have more users and a greater impact on the region. We are also keeping track of the number of media requests which suggests the climate information we are involved with is being integrated into the public sphere. Lastly we are tracking the distribution of the two-page information sheets that we produced about California precipitation and Southern California drought.

10. Please fill out the attached project database template for projects that meet all of the following criteria (NOTE: These criteria are generally a judgment call on the part of the Principal Investigator(s) and/or the Program Managers and do not require extensive analysis. Criteria should NOT be listed in database.):

- Core RISA projects – Determined by one or more of the following:
  - i. RISA investigator is leading the effort
  - ii. RISA is primary source of funding
  - iii. RISA capacity is critical to the project (e.g. Regional Chapters/Technical Inputs of the NCA)
- Current projects – Determined by one or more of the following:
  - i. Recently completed (i.e. finished within the last six months)
  - ii. Ongoing (i.e. initiated, but not completed)
  - iii. Planned (i.e. funded but not started)

Please see attached PDF.

## PUBLICATIONS

### Peer-Reviewed Journal Articles:

Borsa, A. A., Agnew, D. C. and Cayan D. R., 2014: Ongoing Drought-Induced Uplift in the West, *Science*, 345(6204), 1587-1590, DOI: [10.1126/science.1260279](https://doi.org/10.1126/science.1260279).

Bromirski, P. D., and D. R. Cayan, 2015: Wave power variability and trends across the North Atlantic influenced by decadal climate patterns, *J. Geophys. Res. Oceans*, 120, doi:[10.1002/2014JC010440](https://doi.org/10.1002/2014JC010440).

Cavanaugh, N. R., & Gershunov, A., 2015: Probabilistic tail dependence of intense precipitation on spatiotemporal scale in observations, reanalyses, and GCMs. *Climate Dynamics*, 1-11, doi: 10.1007/s00382-015-2517-1.

Cavanaugh, N. R., Gershunov, A., Panorska, A. K. and Kozubowski, T. J., 2015; The probability distribution of intense daily precipitation. *Geophys. Res. Lett.*, 42: 1560–1567. doi:[10.1002/2015GL063238](https://doi.org/10.1002/2015GL063238).

DeFlorio, M. J., Goodwin I. D., Cayan, D.R., Miller, A.J., Ghan, S.J., Pierce, D.W., Russell, L. M., and Singh, B., 2015: Interannual modulation of subtropical Atlantic boreal summer dust variability by ENSO, *Climate Dynamics*, 1-15, doi: 10.1007/s00382-015-2600-7.

Mahoney, K., Ralph, F.M., Wolter, K., Doeskin, N., Dettinger, M., Gottas, D., Coleman, T., and White, A., 2015: Climatology of extreme daily precipitation in Colorado and its diverse spatial and seasonal variability: *J. Hydrometeorology*, 16, 781-792.

Maurer, E.P., Brekke, L., Pruitt, T., Thrasher, B., Long, J., Duffy, P., Dettinger, M., Cayan, D., and Arnold, J., 2014: An enhanced archive facilitating climate impact analysis, *Bulletin of the American Meteorological Society.*, 95, 1011-1019, DOI:10.1175/BAMS-D-13-00126.1.

Maurer, E. P. and Pierce, D. W., 2014: Bias correction can modify climate model simulated precipitation changes without adverse effect on the ensemble mean, *Hydrol. Earth Syst. Sci.*, 18, 915-925, doi:10.5194/hess-18-915-2014.

Meadow, A.M., Ferguson, D.B., Guido, Z., Horangic, A., Owen, G. and Wall, T., 2015: Moving toward the Deliberate Coproduction of Climate Science Knowledge. *Wea. Climate Soc.*, 7, 179–191, doi: <http://dx.doi.org/10.1175/WCAS-D-14-00050.1>.

Li, H., Kanamitsu, M., Hong, S. Y., Yoshimura, K., Cayan, D. R., Misra, V., and Sun, L., 2014: Projected climate change scenario over California by a regional ocean–atmosphere coupled model system. *Climatic change*, 122(4), 609-619, doi: 10.1007/s00382-013-1670-7.

Oakley, N. S., and Daudert, B., 2015: Establishing best practices to improve usefulness and usability of web interfaces providing atmospheric data, *Bulletin of the American Meteorological Society*, doi: <http://dx.doi.org/10.1175/BAMS-D-14-00121.1>.

Pierce, D.W., Cayan, D.R., and Thrasher, B.L., 2014: Statistical Downscaling Using Localized Constructed Analogs (LOCA). *J. Hydrometeorol*, **15**, 2558–2585, doi: <http://dx.doi.org/10.1175/JHM-D-14-0082.1>.

Steinemann, A., Iacobellis, S., and Cayan, D., 2015: Developing and Evaluating Drought Indicators for Decision-Making. *J. Hydrometeorol*. doi:10.1175/JHM-D-14-0234.1, in press.

Xu, L., Pierce, D. W., Russell, L. M., Miller, A. J., Somerville, R. C. J., Twohy, C. H., Ghan, S. J., Singh, B., Yoon, J. and Rasch, P. J., 2015: Interannual to decadal climate variability of sea salt aerosols in the coupled climate model CESM1.0. *J. Geophys. Res. Atmos.*, **120**: 1502–1519. doi: [10.1002/2014JD022888](https://doi.org/10.1002/2014JD022888)

Ward, P.J., Jongman, B., Kummu, M., Dettinger, M., Sperna-Weiland, F., and Winsemius, H., 2014, Strong influence of El Nino/Southern Oscillation on flood risk around the world: Proc. National Academies of Science, 6 p., doi://[10.1073/pnas.1409822111](https://doi.org/10.1073/pnas.1409822111).

Williams, A. P., Schwartz, R. E., Iacobellis, S., Seager, R., Cook, B. I., Still, C. J., Husak, G. and Michaelsen, J., 2015: Urbanization causes increased cloud base height and decreased fog in coastal Southern California. *Geophys. Res. Lett.*, **42**: 1527–1536. doi: [10.1002/2015GL063266](https://doi.org/10.1002/2015GL063266).

### **Books/Articles-in-Books:**

Florsheim, J., and Dettinger, M., 2015: Promoting atmospheric-river and snowmelt fueled biogeomorphic processes by restoring river-floodplain connectivity in California's Central Valley: in Hudson, P., and Middelkoop, H. (eds.), *Geomorphic approaches to integrated floodplain management of lowland fluvial systems in North America and Europe*, Springer, 117-140, DOI 10.1007/978-1-4939-2380-9\_6. **[due out in June 2015]**

### **Reports:**

Albano, C., Cox, D.A., Dettinger, M.D., McCarthy, M., Schaller, K., and Wellborn, T., 2014: ARkStorm@Tahoe--Stakeholder perspectives on vulnerabilities and preparedness for an extreme storm event in the greater Lake Tahoe, Reno, and Carson City region: University of Nevada Cooperative Extension Special Report 14-16, 43 p.